MASSACHUSETTS INSTITUTE OF TECHNOLOGY

2.71 Optics **Fall '04**

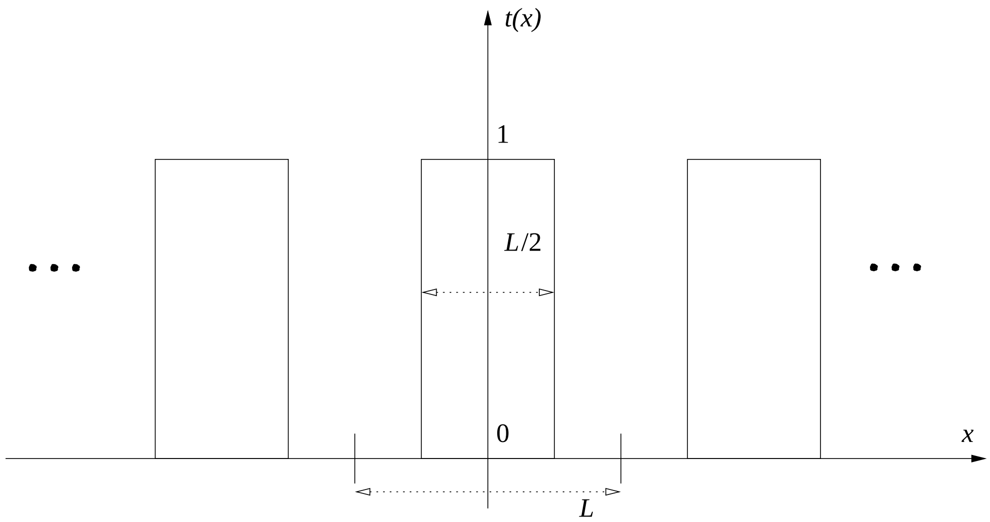
Problem Set #7 Posted Wednesday, Oct. 27, 2004 — Due Wednesday, Nov. 3, 2004

1. A spherical wave is incident on a Fabry-Perot cavity interferometer implemented as a dielectric slab of index n. The wavelength of the spherical wave in vacuum is λ. The spherical wave originates a distance $d = 10^3\lambda$ to the left of the front face of the cavity. The cavity length is $L = 10\lambda/n$ and the intensity reflection coefficient of each face of the cavity is $R = 0.95$. Describe the interference pattern that would be observed on a screen placed a very small distance to the right of the back face of the cavity.

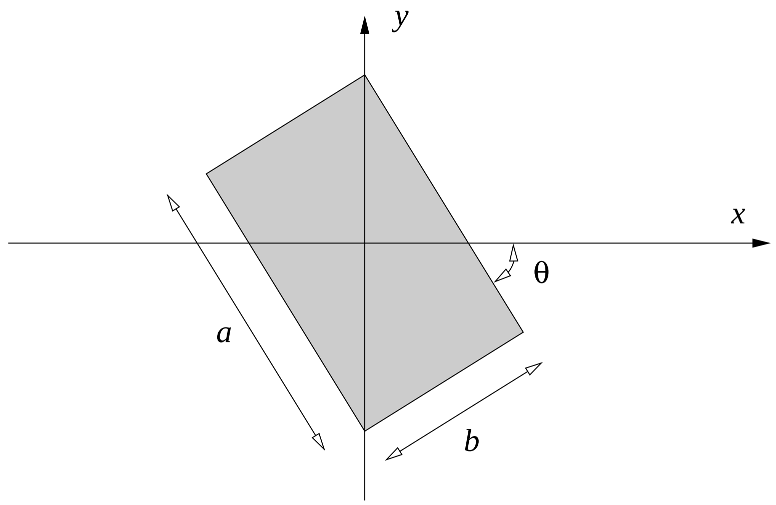
2. Consider the one-dimensional periodic function shown below. In the field of Optics, this is often refered as a "Binary grating" of infinite extent.

2.a) Calculate the Fourier series coefficients of that periodic function in closed form.

2.b) Write down the Fourier transform of a single boxcar, *i.e.* a single period of this function. What do you observe?



3. Tilted aperture. Calculate analytically and sketch the Fourier transform of the tilted aperture shown below (the aperture has value one inside the tilted rectangle and zero outside). The edge lengths are $a = 10\mu$m, $b = 5\mu$m and the tilt is $\theta = 60°$. *Hint*: First calculate the Fourier transform of the same aperture oriented upright; then rotate the (x, y) coordinates.



4. **Tilted binary grating.** Calculate analytically and sketch the Fourier transform of the limited-aperture grating shown below (the aperture has value one at the locations shown as white and zero everywhere else.) Assume spatial period $\Lambda = 10\mu$m, stripe size $d = 2\mu$m, tilt $\theta = 30°$ with respect to the aperture, and edge lengths $a = 5$mm, $b = 3$mm. *Hint*: First calculate the Fourier transforms of the tilted grating and the aperture individually. Then use the convolution theorem.